**STATEMENT OF GANESH BELL**

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**BEFORE THE COMMITTEE ON ENERGY AND COMMERCE**

**"MODERNIZING ENERGY AND ELECTRICITY DELIVERY SYSTEMS. CHALLENGES AND OPPORTUNITIES TO PROMOTE INFRASTRUCTURE EXPANSION AND IMPROVEMENT"**

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## INTRODUCTION

Chairman Upton, Ranking Member Rush, and Members of the Subcommittee on Energy, thank you for the opportunity to testify before you today on this important topic. My name is Ganesh Bell. I am the Chief Digital Officer of GE Power, the largest of General Electric's businesses providing technology for electricity generation, transmission, distribution and consumption management. I have spent my entire career in the software industry, and work today at the intersection of the industrial world and the digital world, bringing new software-driven solutions to traditional industrial problems.

## GE POWER

As many of you will know, GE has long been a leader in the electricity industry. We have a global team of more than 330,000 employees, operate in 175 countries around the world, and our technology generates one third of the world's electricity. Our four electricity businesses, GE Power, GE Renewables, GE Energy Connections and Current together offer a portfolio of industrial hardware, software and services for renewable, nuclear and fossil power generation, electricity transmission & distribution, and commercial and industrial energy management. In sum, these businesses account for 45% of GE's industrial segment revenues, or about $51 billion. As I mentioned, I am also part of a new digital organization at GE - GE Digital – which employs more than 20,000 people focused on solving business problems in diverse industries with software.

## DIGITAL TRANSFORMATION OF ELECTRICITY

It is an exciting time to be working in this industry. For a century, the electricity industry – largely unchanged – has powered the development of our economy, transformed society and our industries. Now, electricity itself is being transformed. Traditional energy infrastructure is becoming smarter just as the industrial base of the country is transforming into the digital industrial base.

The industry's mix of fuel is rapidly evolving with the addition of more diverse and distributed generation sources. Different countries and even different U.S. states will embrace different mixes of fuels, enhancing, but also challenging the stability and capacity of the grid.

More devices are becoming connected. Already 600 million smart meters are connected. There will be more than 20 billion devices connected by 2025. Billions of them will be in the electricity value chain generating valuable data.

This wave of connectivity and innovation is being enabled by a set of technologies coming together to form what we call the Industrial Internet. The combination of cloud computing, data science, low cost sensors and the Internet of Things applied to industry is allowing the merger of physical infrastructure and digital systems.

Modern power plants already generate terabytes of data per day. Wind turbines capture data every 10 seconds. There are already a billion connected electricity devices and assets, more than half of which are smart meters. The data being generated by these assets could be incredibly

valuable to improving our understanding, and thereby the operating efficiency of the whole system, but less than 2% of that data is being analyzed and used today.

We believe this transformation of our electricity infrastructure will generate significant societal benefits, from job creation to capturing the expertise of an ageing workforce, reducing emissions and lowering the cost of electricity to consumers.

GE recognized this challenge and opportunity in our own business five years ago. As part of an effort to find new productivity and growth we began to invest in digitalization projects that would enable us to better understand the performance of the machines we make, and the processes by which they are made and maintained. We believed digitalization would drive cost out of our business and accelerate innovation for the benefit of our customers and our shareholders.

When we say digital and digitalization, we are referring to collecting data from sensors attached to traditional electricity infrastructure and machines such as steam turbines, aircraft engines and locomotives. We then use analytic software to compare data with physics-based models of those machines – called Digital Twins - so that we might better understand their current, and predict their future, performance.

Digitalization also refers to making manual work processes such as the inspection of machines and the scheduling of maintenance and repairs more efficient through software.

In the past year, digitalization initiatives of both types generated $700M in savings for GE, which we reported as productivity in our most recent quarterly earnings call.

Upon seeing benefits of this scale, we realized digital technologies could generate tremendous value if applied companywide, industrywide, and even to industries and infrastructure in which GE does not traditionally operate.

As Chief Digital Officer for GE Power, my mission has been to evolve those digitalization projects into cloud-based commercial software products; to devise GE's strategy for bringing those products to market in the electricity industry, and to work closely with our power producer and utility customers to implement them.

I should underscore that GE has unique expertise in the electricity industry. More than one third of the world's electricity is generated using machines made by GE. Our expertise in building and servicing machine infrastructure has given us unique insights in developing software to improve their reliability, productivity and profitability, and ultimately the performance and profitability of entire power plants and utilities.

## DIGITALIZATION IN ACTION

Digital technologies have helped our customers bring more agility and responsiveness to the capability of their generating infrastructure. This is particularly important as the fuel mix evolves to include more renewables, more distributed energy resources, and greater electrification of

transportation and building energy management systems. In the face of growing variability in supply and demand, software helps utilities plan for, and respond more rapidly, to change, and at lower cost, adding to the reliability and resilience of the grid.

For example, GE's software enables power producers to more accurately and quickly forecast energy derived from renewables. It also enables traditional fuel sources to ramp up more quickly and more efficiently when responding to fluctuations in supply and demand. Traditional generation types were not designed to ramp-up rapidly and often, and therefore tend to do so inefficiently and with higher emissions. These digital technologies improve starting reliability, heat rate and fuel consumption so that fossil power can run more profitably even when it is no longer running as a base load generator.

Second, our digital technologies have dramatically reduced unplanned downtime in traditional generation environments, thereby also contributing to overall grid reliability and stability. I ride a motorcycle as a hobby, but you don't need to have your own to know that regular inspection and maintenance, including the replacement of worn parts, will improve the performance of a bike. The same is true for electricity generating machines, only it is much harder to inspect and conduct maintenance on a machine that is operational 24 hours a day, 7 days a week. By collecting and analyzing sensor data – and comparing that data with Digital Twins – it becomes possible to identify anomalies that may indicate a future breakdown or sub-par performance, without taking the machine offline. Plant operators and control systems can then use this data to fine tune performance to reduce fuel consumption, emissions, ramp rate and more. Today's digital technology can eliminate as much as 80% of all unplanned downtime, increasing total plant availability by 10%.

I want to stress that addressing unplanned downtime alone presents a tremendous opportunity to enhance the efficiency of electricity in the US. According to NERC, the US fleet operates at less than 50% of potential capacity. Generating units are unavailable on average for 15% of the time due to outages and maintenance. 6% of the time they are unable to meet demand at all. The EIA highlights that a further 6% of electricity is lost in transmission and distribution due to both technical factors and outages. Digital can play a huge role in optimizing this infrastructure.

On a related note, and third, our digital technologies are helping the nuclear industry deliver on its Nuclear Promise to reduce operations and maintenance costs 30% by 2018. Digital helps support this goal by predicting with a high degree of accuracy when SCRAMs (Safety Control Rod Axe Man) - the nuclear industry's name for unplanned downtime - will occur. Our software can predict SCRAMs with as high as 90% accuracy, enabling operators to conduct proactive maintenance at a significantly lower cost and with less interruption.

Benefits such as these can generate savings of $50M over the lifetime of an existing plant, or as much as $200M in a new plant when the latest hardware and software are combined.

Applied industry-wide, the World Economic Forum has estimated that digital transformation of electricity infrastructure could generate $1.3T in value worldwide in the next 10 years, with an additional $2T in societal value. The economic impact is particularly important to improving

productivity in an industry experiencing very low demand growth in the US, as it is in most developed markets.

The economic value from existing infrastructure will be derived from factors such as reduced fuel consumption, increased generation capacity, faster time-to-generation, total plant availability and industrial worker productivity. Almost one third of that economic value ($387B) could be derived by reducing unplanned downtime in the electricity industry. We believe we can eliminate as much as 80% of all unplanned downtime with this type of software.

The societal benefits will include significant job creation in areas such as data science, energy storage integration, smart asset planning and asset performance management. As many as three million jobs could be created worldwide. Digitalization will also help capture expertise from an ageing workforce. As this Committee is likely aware, 25 percent of electricity industry employees will be ready to retire in the next five years. Lastly, we anticipate societal benefits from reducing emissions and from financial benefits passed on to customers.

Early adopter customers are beginning to experience these benefits on individual machines and plants but the real value of electricity digitalization to the United States will be derived from the digitalization of the entire electricity infrastructure value chain. That shift will bring innovation at a speed at scale that we have only witnessed so far in the consumer Internet. Let me expand on that comparison for a moment as I describe what we call the creation of the Electricity Value Network.

## THE ELECTRICITY VALUE NETWORK

I think the members of the Committee will recognize that several technology companies have created very efficient software platforms for connecting demand and supply. Amazon, Apple, eBay and Uber have all built platforms that removed the friction associated with finding a product or service, and in connecting sellers to an online marketplace. There are myriad other examples from other industries, but they all have one thing in common: the efficient mapping of demand and supply, and the digitalization of processes required to bring the two together. It is our belief that the digitalization of the electricity industry and the creation of an Electricity Value Network will be similarly valuable.

By applying digital to individual connected assets - a boiler in a coal plant, a wind turbine, or a grid substation – we can reduce downtime, elevate productivity and output, and – in the case of traditional fuels – reduce emissions.

By connecting entire fleets of assets, we will be able to dramatically enhance our ability to forecast supply, to dynamically increase or decrease supply in response to fluctuations in demand or resource variability, and to optimize overall production for a host of factors – from profitability to emissions and fuel consumption.

By connecting the workers and the processes by which the electricity industry is operated and maintained, we can catch potential outages earlier, address them faster, improve the safety of operations, and dramatically reduce the cost of operations.

By connecting every customer, generator, grid operator, battery, building, HVAC system, light fixture, and transportation mode – every possible node of the electricity value network's infrastructure – entirely new business models will emerge that can underpin the development of smarter cities and stronger and healthier economies.

The electrification of building energy management and of transportation systems to reduce emissions and energy consumption are two excellent examples. In the State of New York, transportation accounts for 34% of the State's emissions and $26.7 billion in fuel costs. New York's buildings consume roughly 60% of its total energy. An Electricity Value Network could play a significant role in reducing emissions and energy consumption through electrification.

**IMPEDIMENTS TO DIGITALIZATION OF THE ELECTRICITY INDUSTRY**

The electricity industry has an exciting opportunity to modernize its infrastructure and to create new value by doing so, but we do not underestimate the obstacles to digitalization. The transformation overall will require enlightened leadership particularly with regards to technology adoption, but there are two challenges that stand out: the need for new skills, and cybersecurity.

First, the industry's workforce is facing challenges. As has been extensively documented by the Energy Department, the industry has an ageing workforce, and it is struggling to recruit engineering and technical talent in sufficient numbers to offset retirements and meet future needs. These challenges are likely to be exacerbated by digital transformation, which requires new technical and leadership skills. The days when expertise passed from generation to generation could sustain the industry's development are likely over. The next generation of workers will not only be industrial workers – they will need be digital industrial workers.

Acknowledging the opportunities for next generation jobs in a digital infrastructure economy, at GE Digital's New Orleans Digital Hub we have partnered with the University of New Orleans to train and mentor the next generation workforce. The successful Software Engineering Apprenticeship Program (SWEAP) brings students each year for a two-year Digital internship with the promise of a fulltime position as a software engineer, developer or analyst upon graduation. This is one example as to how GE will develop talent and create jobs along its digital industrial transformation.

Second, the reliability of the electricity supply is naturally of the utmost importance to our power producer and utility customers, and they are concerned that the evolution of the electricity value chain into a connected network infrastructure – an Electricity Value Network – and the use of data analytics software delivered via the cloud could make it more vulnerable to cyberattacks. It is our strongly held conviction that security in the cloud, of the type GE provides, is more reliable, more consistently applied, and more rapidly updated than today's approaches.

Naturally, the choice of provider matters, but the best cloud providers make investments in security software, capabilities, processes and personnel that are tested and leveraged at scale across multiple customers. Reduced variation in a cloud environment also means that strict security software and standards can be implemented and enforced across all customers rapidly, with the latest security patches and fixes instantly and continuously.

While this wave of technology is still in its nascent phase in terms of deployment, I would stress that neither of the challenges I have outlined have significantly impeded adoption to date. In fact, 2016 was something of a tipping in the industry, with more than 30 of the world's leading power producers and utilities adopting GE's cloud-based software for the first time.

**CONCLUSION**

In conclusion, the digital transformation of the electricity industry and its infrastructure represents a very significant opportunity to modernize and elevate the competitiveness of our energy sector. It will also add new skilled jobs at a faster rate than automation will eliminate them, and, very importantly, it will enable our power producers and utilities to deliver electricity to citizens at a reduced cost.

GE customers such as New York Power Authority, PSEG, NRG and Exelon are already realizing these opportunities to improve the reliability, resiliency and security of our nation's critical infrastructure. If we can accelerate the deployment of these technologies to the entire industry, the United States has an opportunity to ensure that the country that invented the grid once again has the world's best electricity infrastructure.

Given the myriad benefits of applying digital technology to electric power production and distribution – benefits that accrue to consumers, to utilities, and to the environment – the federal government should explore ways to encourage the responsible adoption of these digital technologies as a core part of our national electricity infrastructure strategy.

We would welcome the opportunity to collaborate with this Committee in furthering that objective, and in ensuring provisions are made to invest in the development of the new skills that will be required to modernize our public electricity infrastructure.

Thank you for holding this important hearing, and for the opportunity to present this testimony. I look forward to your questions, and working with you over the longer term to help accomplish new levels of reliability, efficiency and innovation in the electricity sector.

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